Physiotherapy Department

Biomechanics

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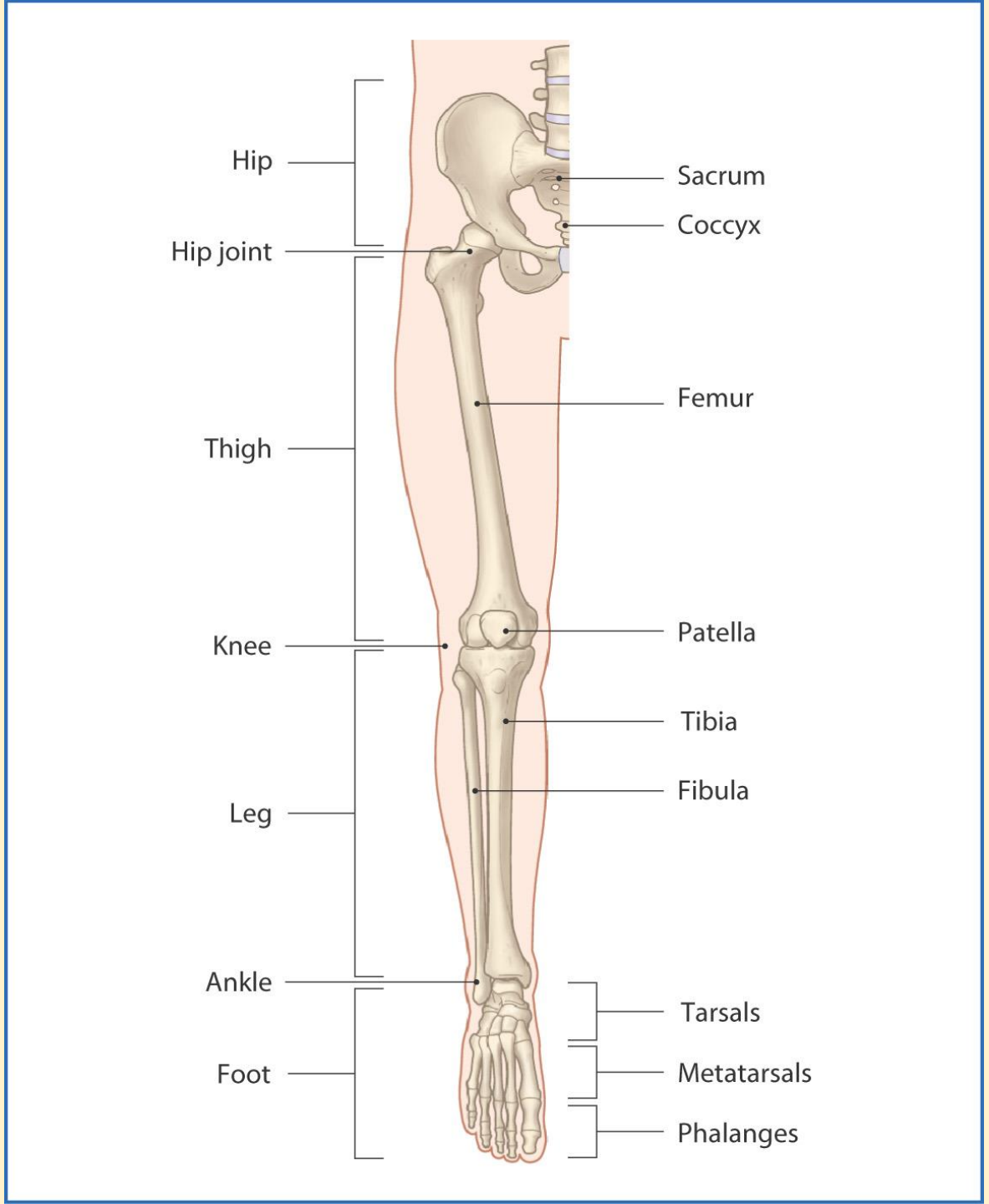
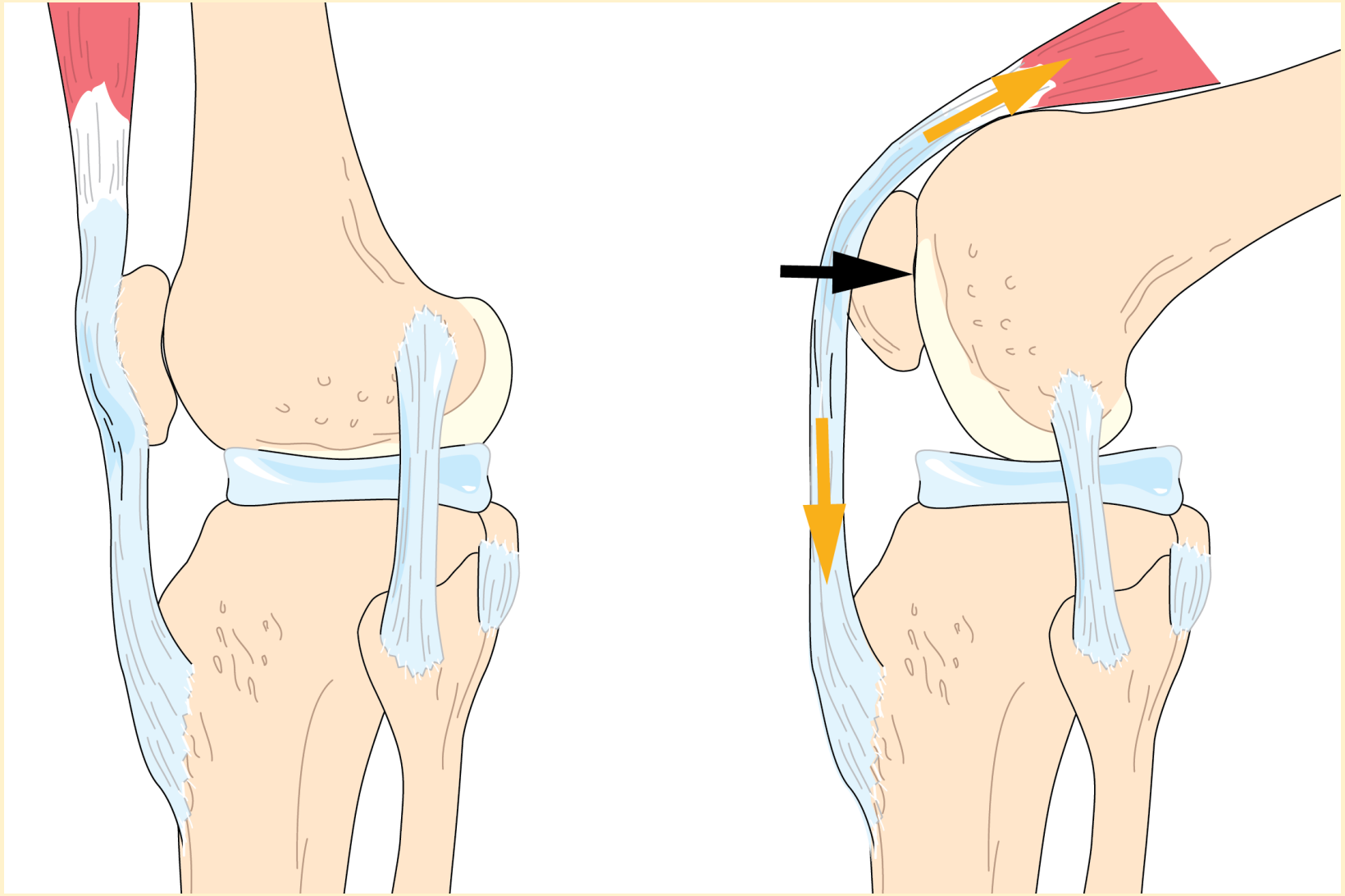
Biomechanics of the Joints of Lower Limb



Biomechanics of the Knee



Lecture 10

Biomechanics of the Knee

19-12-2023

Synopsis

- Overview
- Articulation
- Osteokinematics
- Arthrokinematics
- Muscles acting on the joint

Objectives

- By the end of this lecture, students should understand and be able to describe the basic biomechanics of the knee as follows:
  - Articulation
  - Osteokinematics
  - Arthrokinematics
  - Muscles acting on the joints

Biomechanics of the knee joint

Articulation

- Knee is composed of two distinct articulations enclosed within a single joint capsule:
  - Tibiofemoral joint
  - Patellofemoral joint
- At the tibiofemoral joint:
  - The proximal joint surfaces are the convex medial and the lateral condyles of the distal femur
  - Posteriorly and inferiorly, the longer medial condyle is separated from the lateral condyle by a deep groove called the intercondylar notch

Biomechanics of the knee joint

- Anteriorly, the condyles are separated by a shallow area of bone called the femoral patellar surface
- The distal articulating surfaces are the two shallow concave medial and lateral condyles on the proximal end of the tibia
- Two bony spines called the intercondylar tubercles separate the medial condyle from the lateral condyle
- Two joint discs called menisci are attached to the articulating surfaces on the tibial condyles

- At the patellofemoral joint
  - The articulating surfaces are the posterior surface of the patella and the femoral patellar surface

Osteologic Features of the Distal Femur

- Lateral and medial condyles
- Lateral and medial epicondyles
- Intercondylar notch
- Trochlear (intercondylar) groove
- Lateral and medial facets (for the patella)
- Lateral and medial grooves (etched in the cartilage of the femoral condyles)
- Popliteal surface

Osteologic Features of the Proximal Tibia and Fibula

PROXIMAL FIBULA

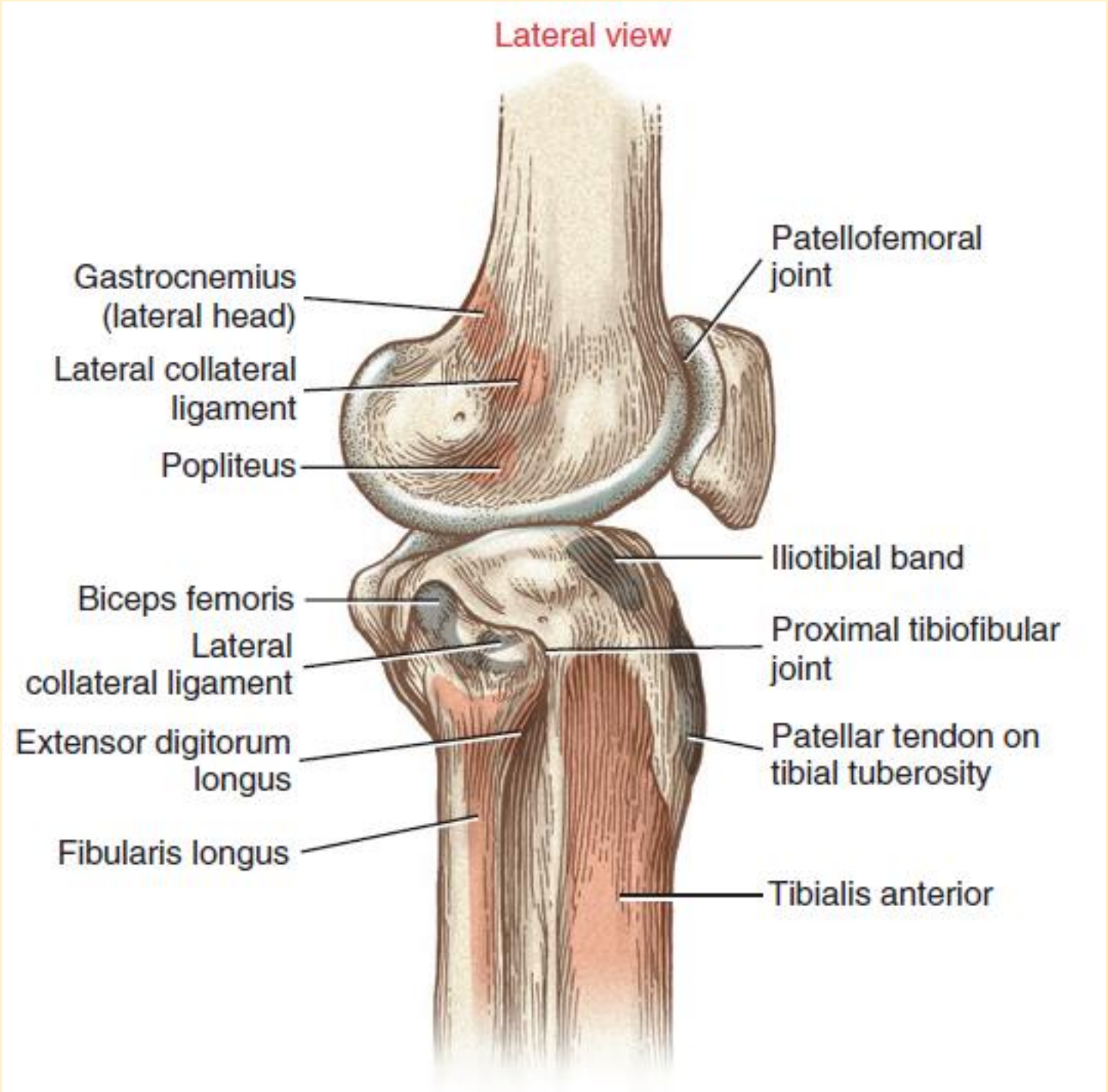
- Head

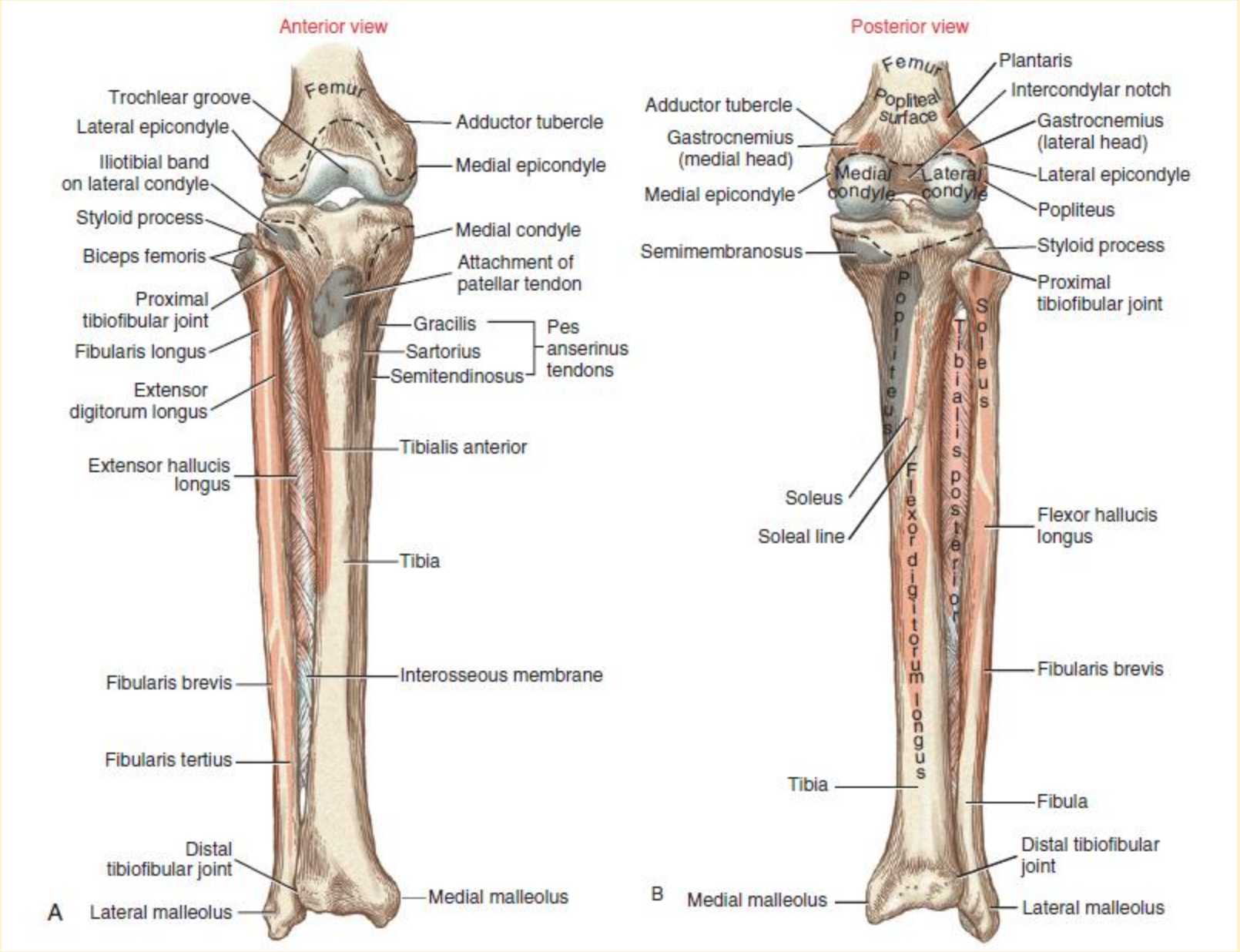
PROXIMAL TIBIA

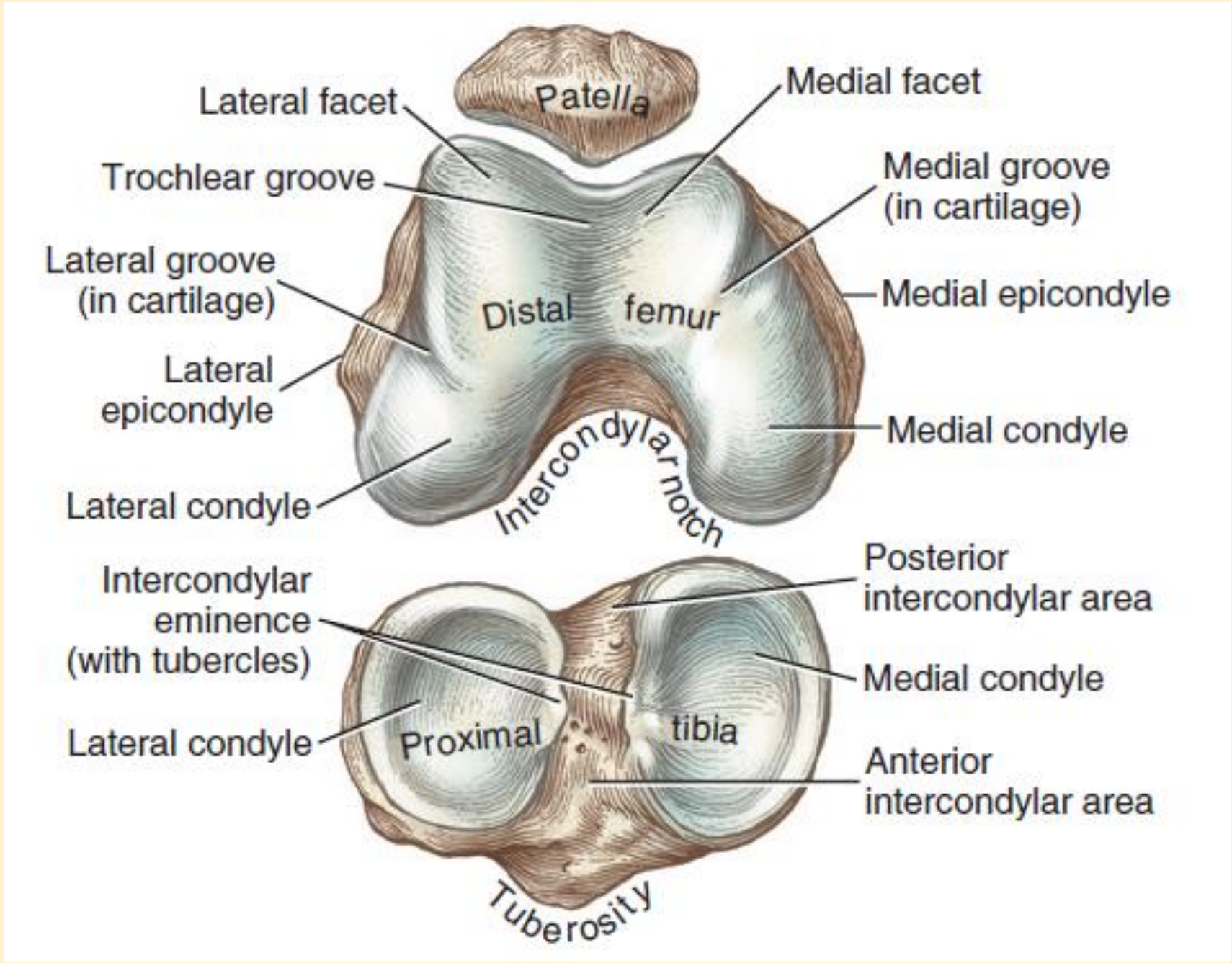
- Medial and lateral condyles
- Intercondylar eminence (with tubercles)
- Anterior intercondylar area
- Posterior intercondylar area
- Tibial tuberosity
- Soleal line

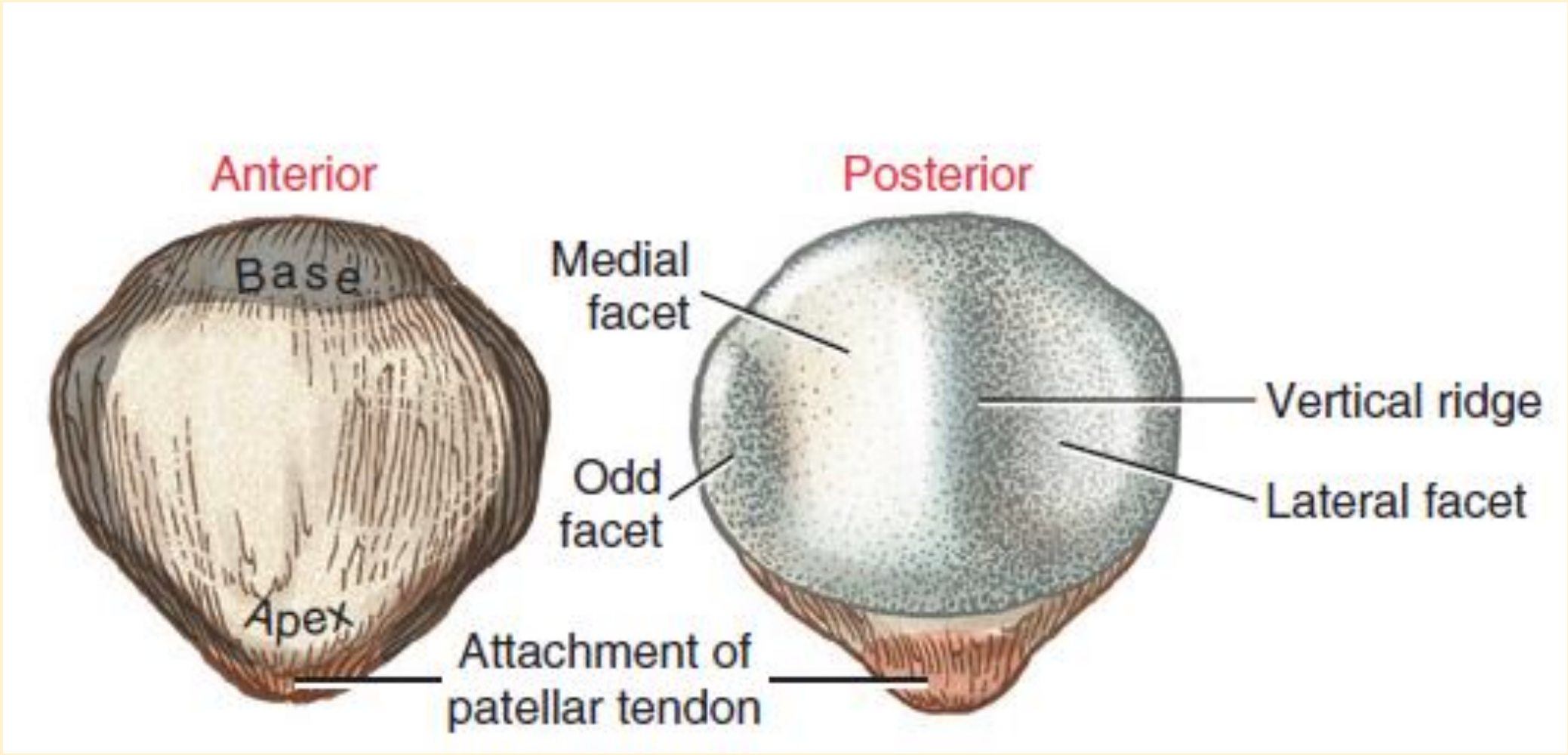
Osteologic Features of the Patella

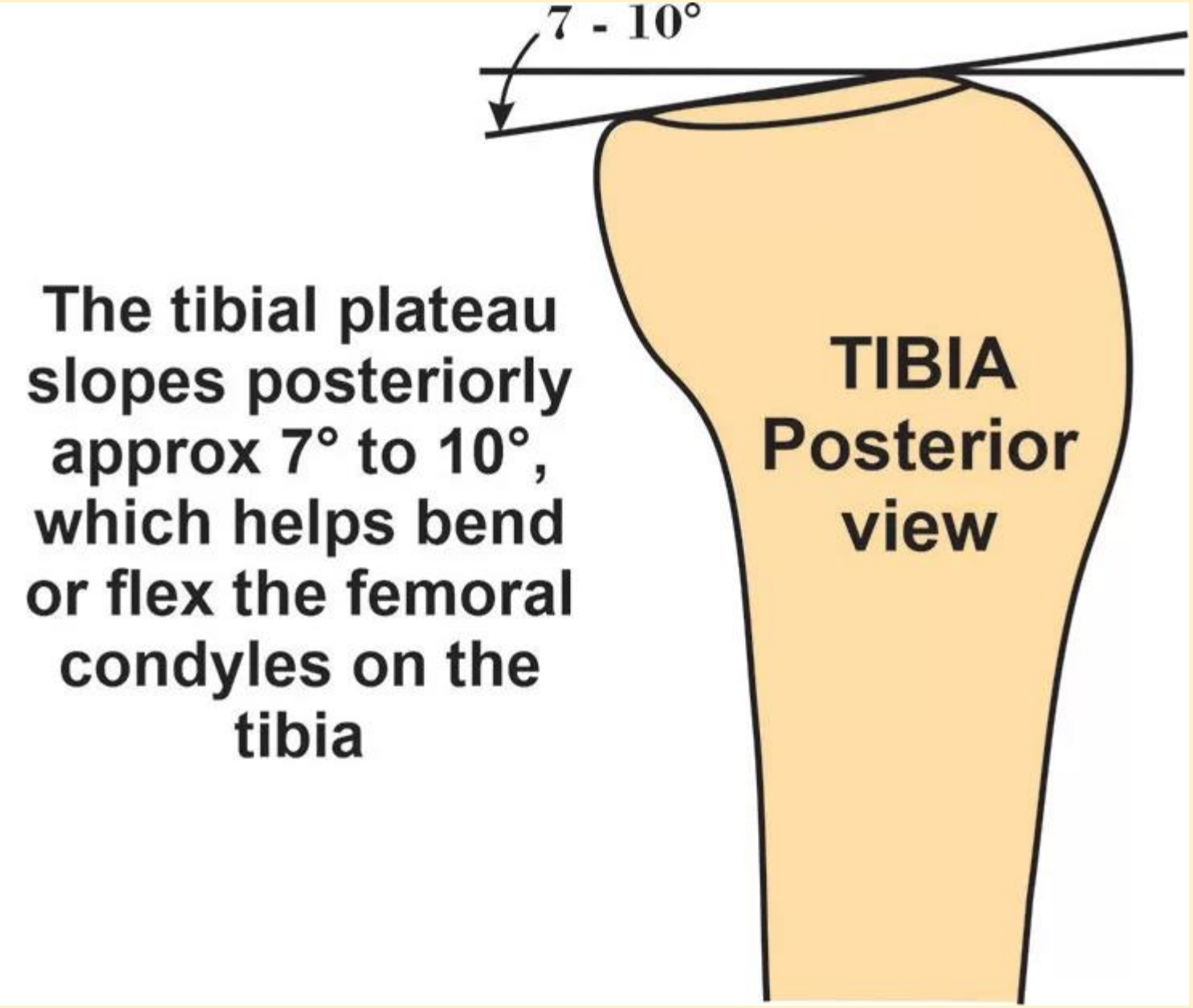
- Base
- Apex
- Anterior surface
- Posterior articular surface
- Vertical ridge
- Lateral, medial, and "odd" facets



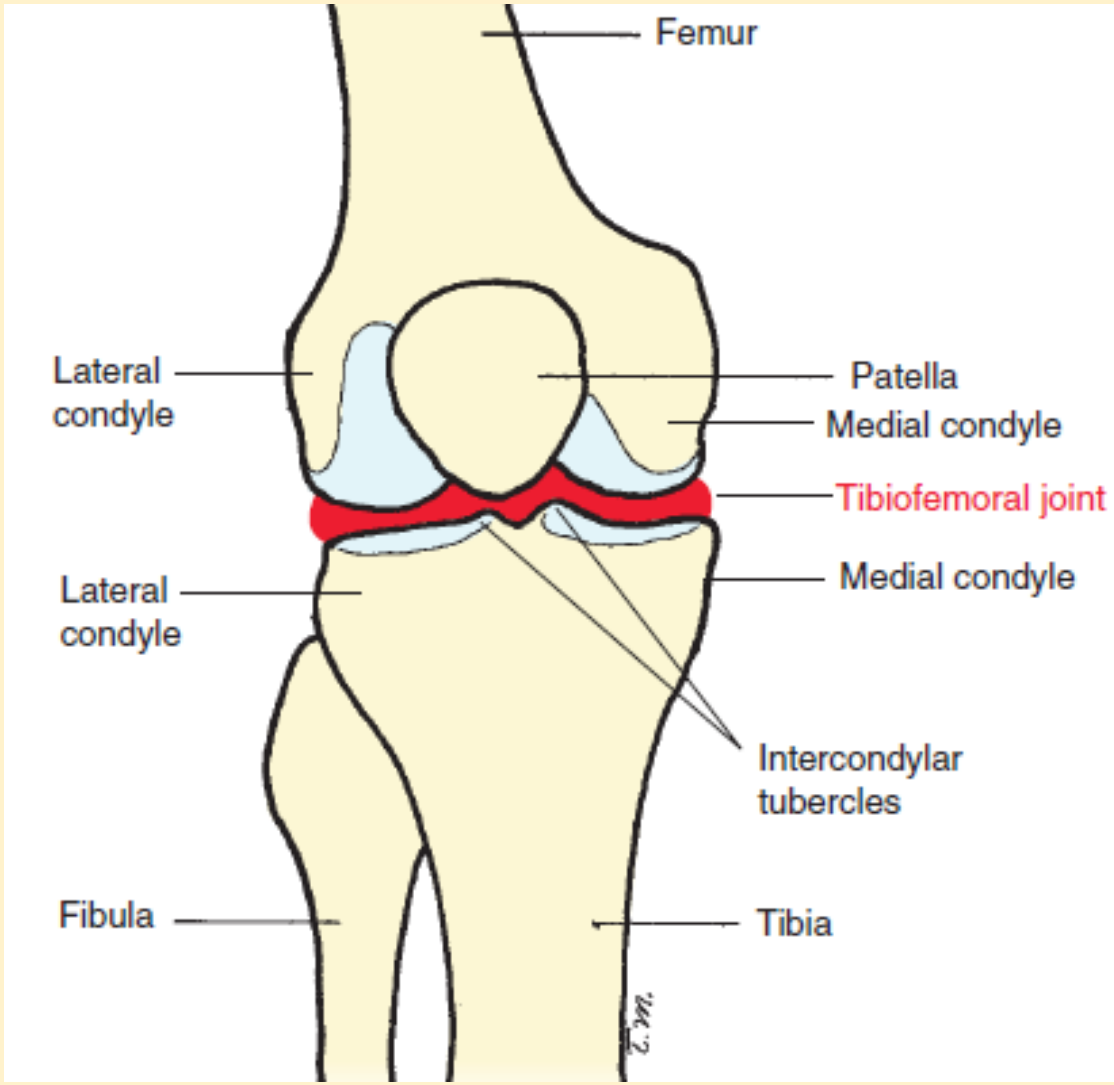


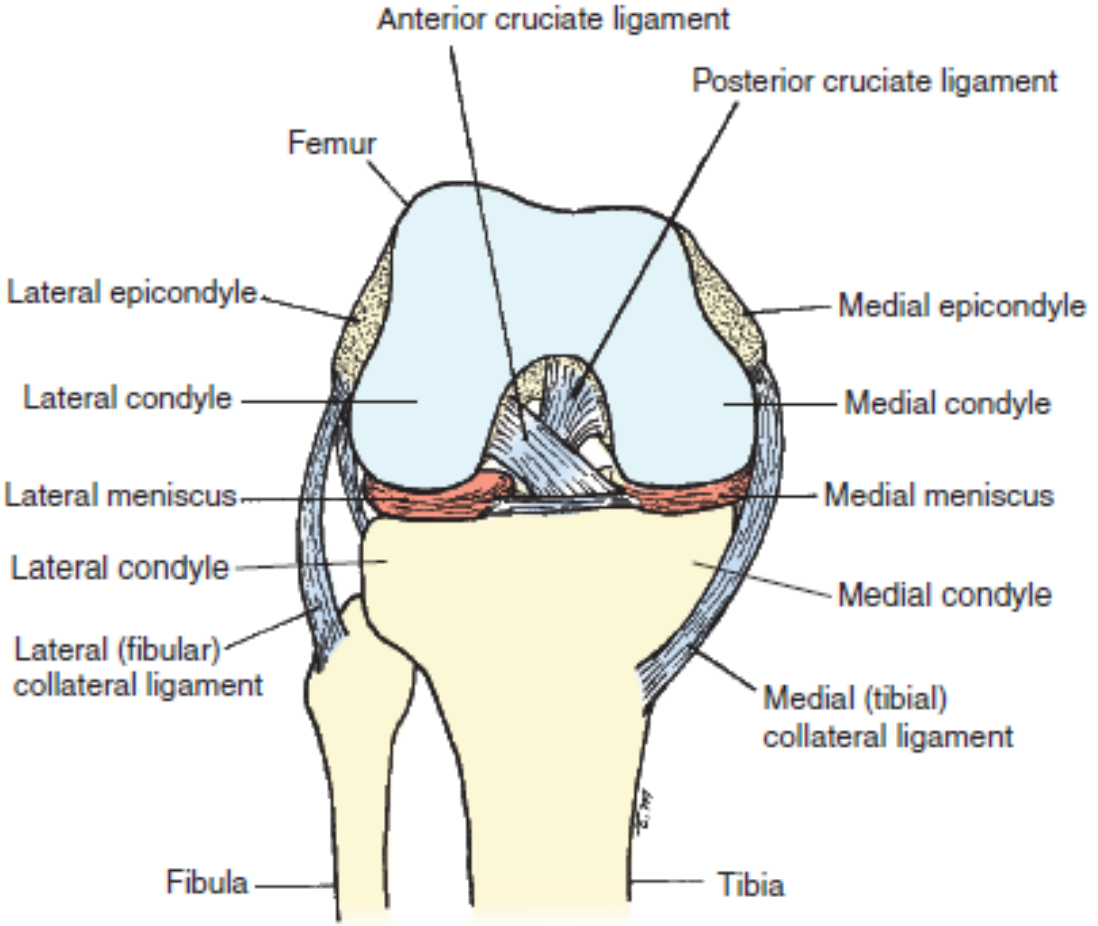






The tibial plateau slopes posteriorly approx 7° to 10°, which helps bend or flex the femoral condyles on the tibia





Biomechanics of the knee joint

- Femoral and tibial longitudinal axes normally form an angle laterally at the knee joint, i.e., lateral angle of the knee

- Normal alignment of the knee within the frontal plane is referred to as ***physiologic genu valgum***, and the angle ranges between 170 to 175 degrees

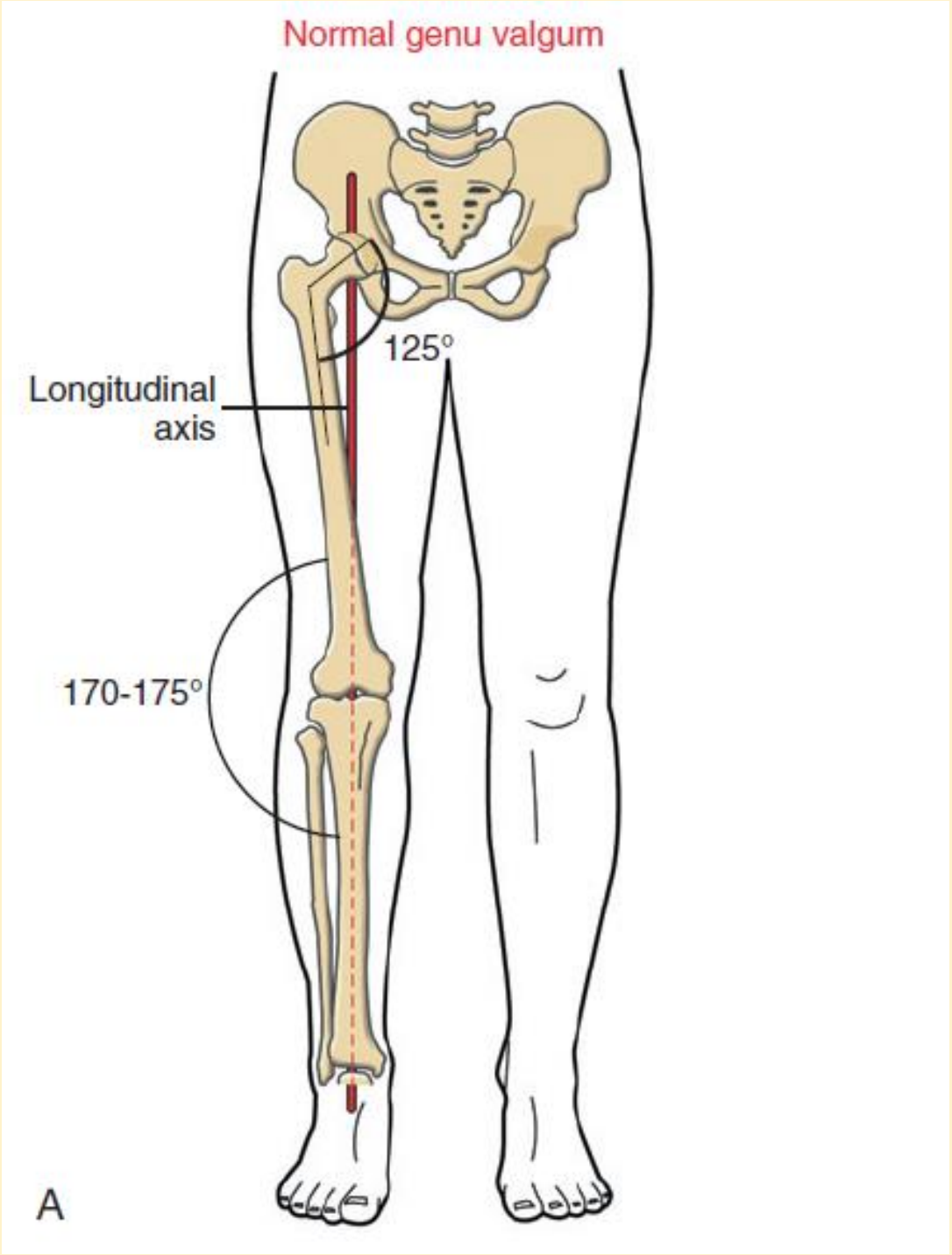
- Q-angle is measured by extending a line through the center of the patella to the anterior superior iliac spine and another line from the tibial tubercle through the center of the patella

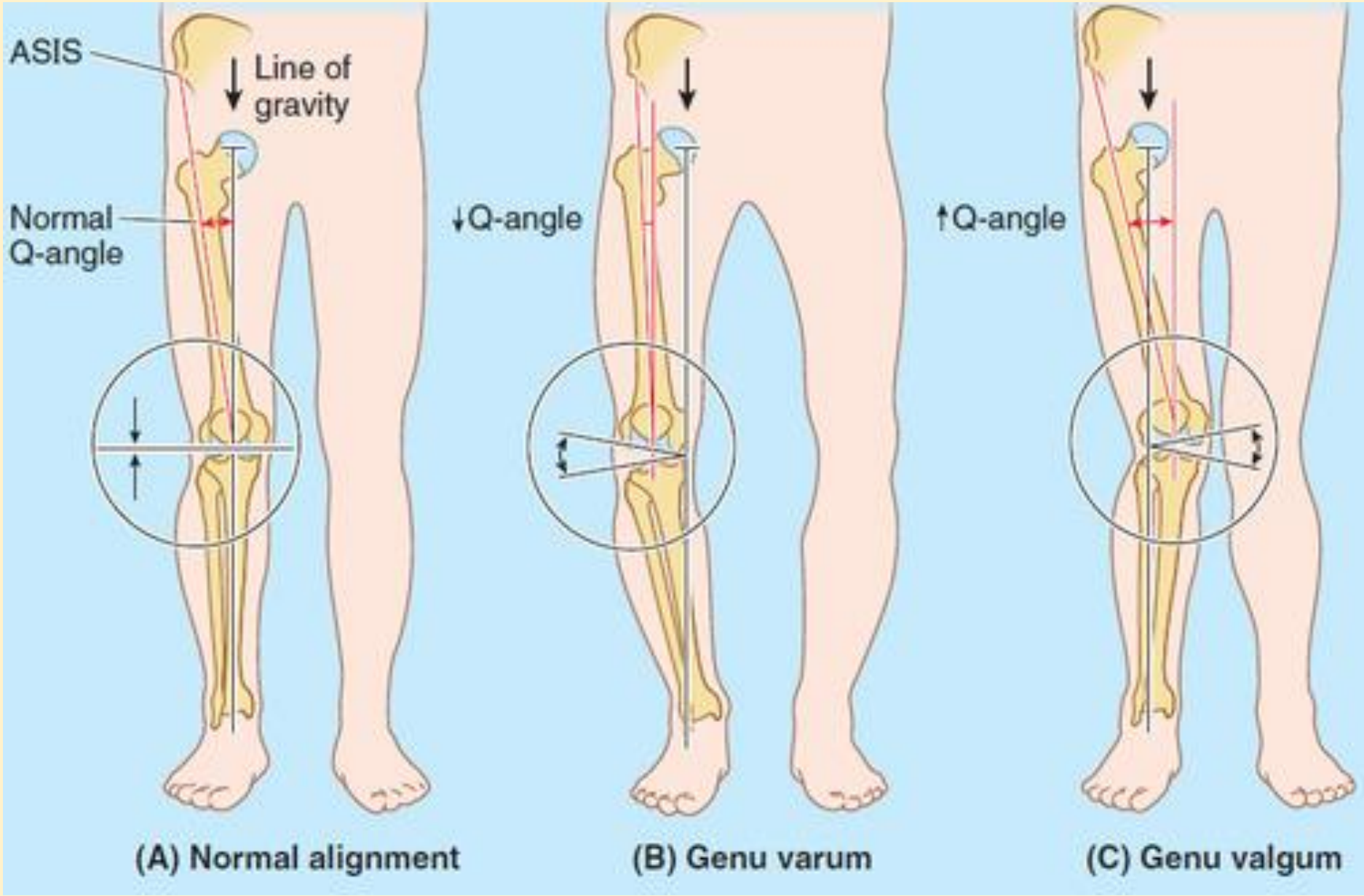
Biomechanics of the knee joint

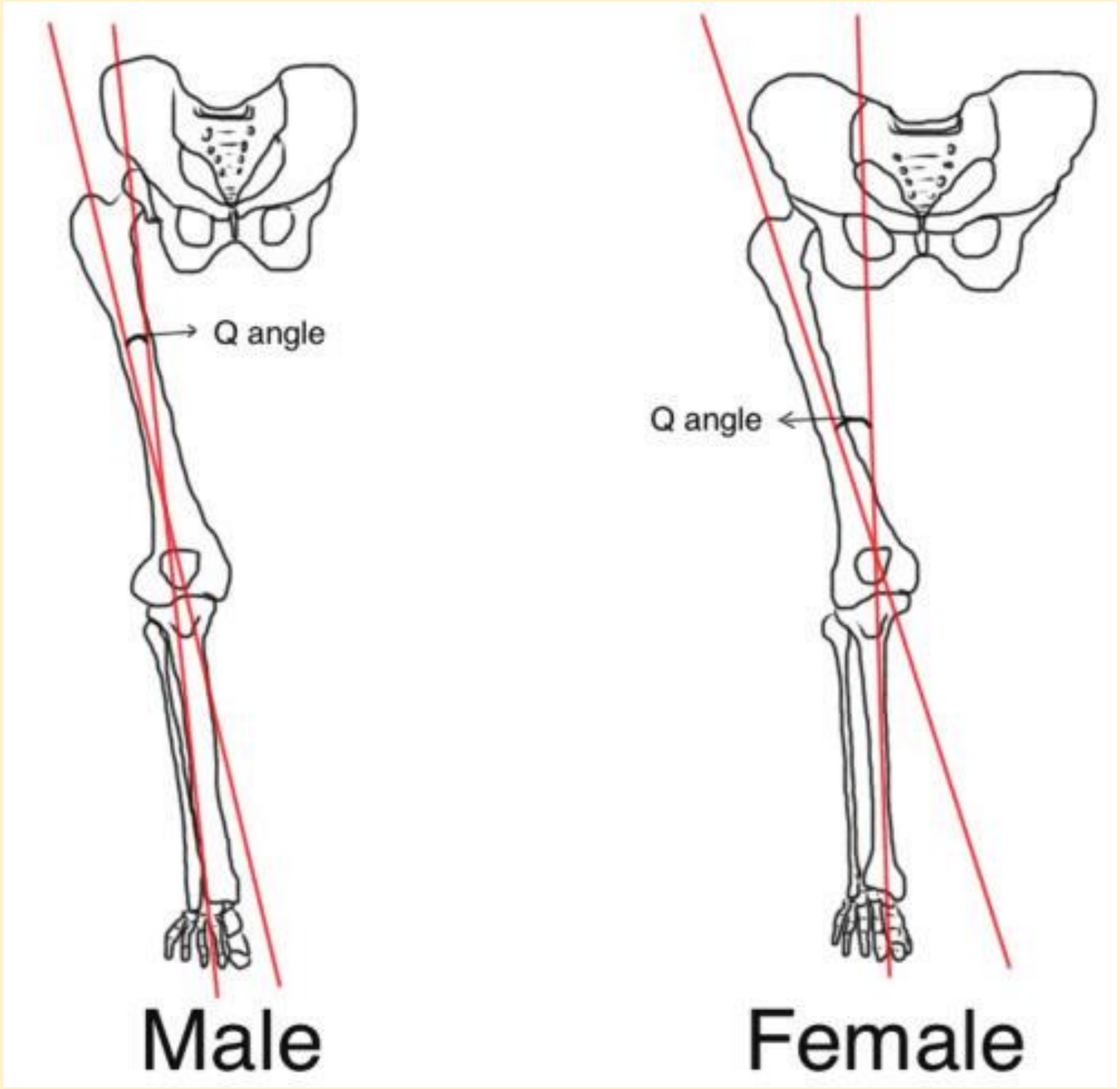
- The intersection of these two lines is the Q-angle; the normal value for this angle is 13 to 18 degrees

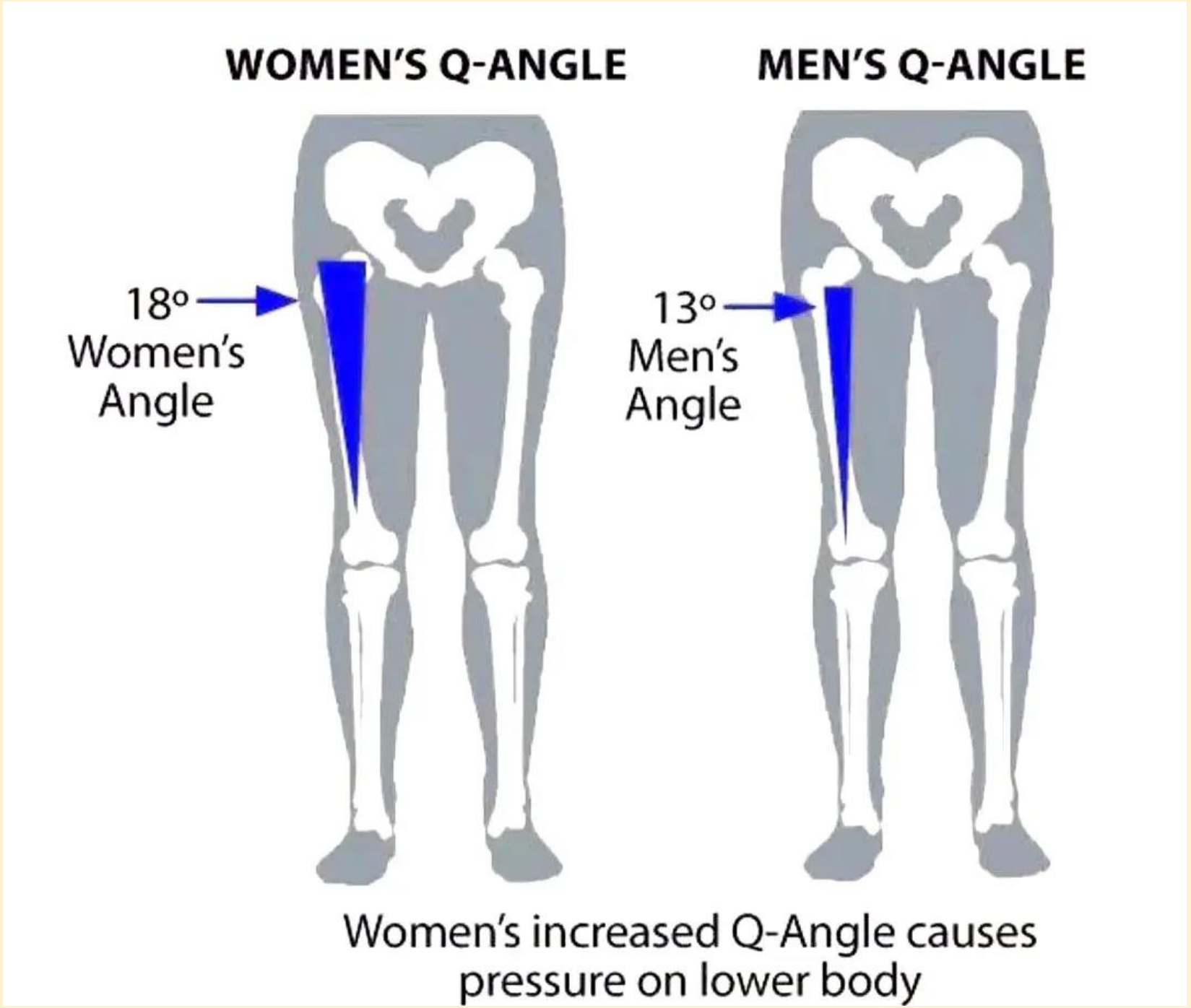
- Q angle > 18 degrees results in ***excessive genu valgum, or "knock-knee"*** (i.e. lateral angle <170 degrees)

- Q angle < 13 degrees results in called ***genu varum, or "bow-leg"*** (i.e. lateral angle >180 degrees)

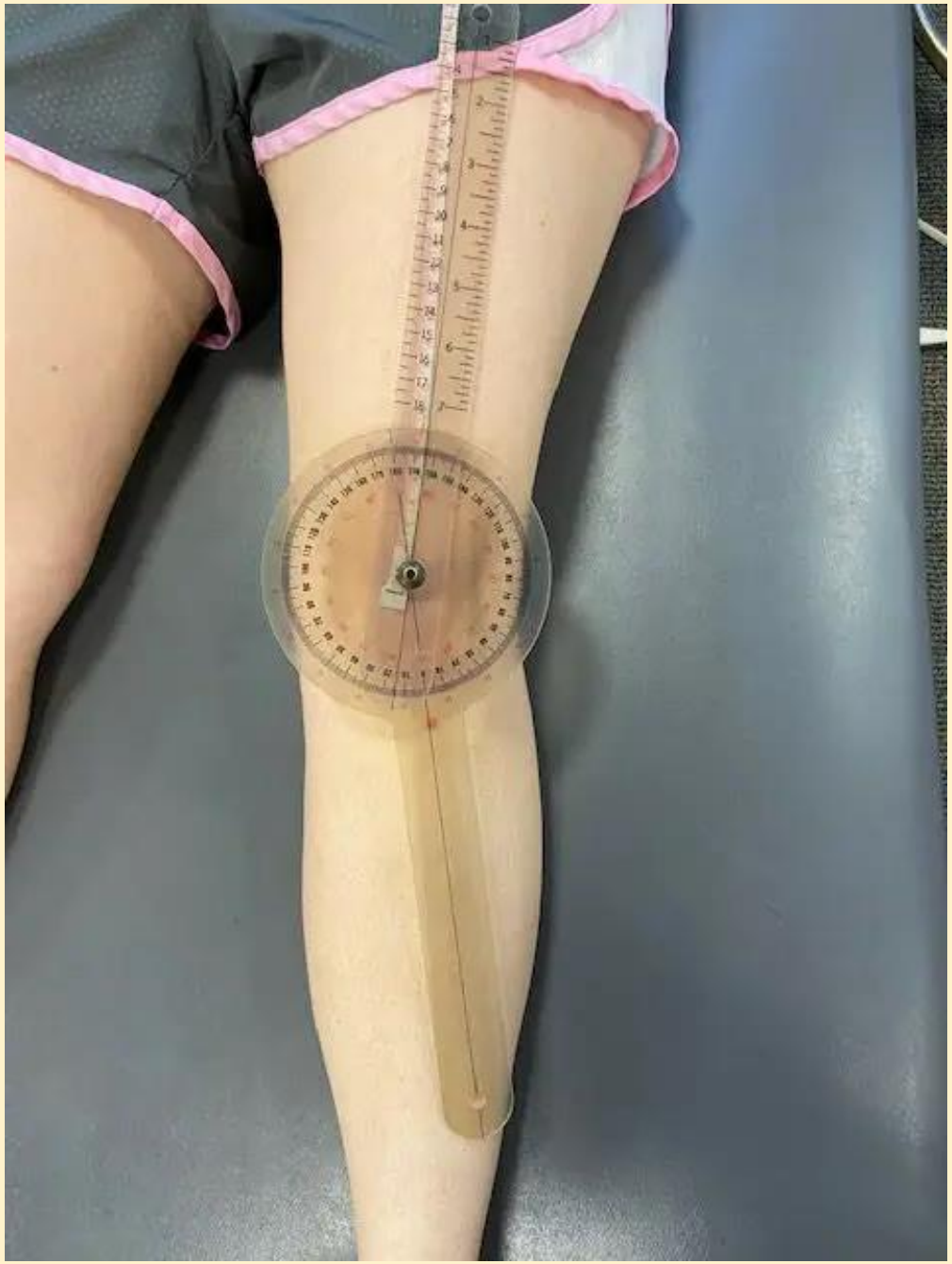








Q-Angle Measurement



Biomechanics of the knee joint

Osteokinematics

- The tibiofemoral joint is a double condyloid joint with 2 degrees of freedom

- Movements available include:
  - Flexion–extension occurs in the sagittal plane around a medial–lateral axis
  - Rotation occurs in the transverse plane around a vertical (longitudinal) axis

Biomechanics of the knee joint

Arthrokinematics

- In non-weight-bearing active motion, the concave tibial articulating surfaces slide on the convex femoral condyles in the same direction as the movement of the shaft of the tibia
  - Tibial condyles slide posteriorly on the femoral condyles during flexion and the tibial condyles slide anteriorly on the femoral condyles during extension
- In a weight-bearing situation the larger articulating surfaces of the convex femoral condyles must roll and slide in opposite directions to remain on the smaller tibial surfaces
- The patella slides superiorly in extension and inferiorly in flexion
- Some patellar rotation and tilting accompany the sliding during flexion and extension

Biomechanics of the knee joint

- During weight-bearing flexion, the femoral condyles roll posteriorly and slide anteriorly
- The menisci follow the roll of the condyles by distorting posteriorly in flexion
- In extension, the femoral condyles roll anteriorly and slide posteriorly
- In the last portion of extension, motion stops at the lateral femoral condyle, but sliding continues on the medial femoral condyle to produce locking of the knee

Biomechanics of the knee joint

Muscles acting on the joints

- Include the following:
  - ➢Flexors
  - ➢Extensors
  - ➢Medial rotator
  - ➢Lateral rotators

Muscles acting on the knee joint	
Flexion	Biceps femoris, semitendinosus and semimembranosus; initiated by popliteus; assisted by gracilis and sartorius
Extension	Quadriceps femoris (rectus femoris, vastus lateralis, vastus medialis and vastus intermedius) assisted by tensor fasciae latae
Medial rotation	Popliteus, semimembranosus and semitendinosus, assisted by sartorius and gracilis.
Lateral rotation	Biceps femoris

Contributions and Questions

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